4.0 HEALTH RISK CHARACTERIZATION

This section presents an evaluation of the potential noncarcinogenic and carcinogenic risks to public health associated with the use as a domestic water source of untreated groundwater from the contaminated aquifer underlying the Muscoy Plume OU area. The estimation of risk assumes that exposure remains constant over the exposure periods assessed (i.e., contaminant concentrations and intake levels are constant) and the risks are from exposure to multiple chemicals (CPOCs) across two reasonable exposure pathways (ingestion and inhalation).

Although synergistic or antagonistic interactions might occur among chemicals, there is currently insufficient information in the toxicological literature to predict quantitatively the effects of such interactions. Therefore, carcinogenic risks and noncarcinogenic hazards are treated as additive within a route of exposure (i.e., the total cancer risk or health hazard is the sum of the risk or hazard for each exposure pathway [EPA 1986b, 1989b]).

4.1 NONCARCINOGENIC RISKS

Noncarcinogenic risk is assessed by comparing the estimated daily intake of a chemical to its RfD. This comparison serves as a measure of the potential for noncarcinogenic health effects not the probability of an adverse effect to occur. The potential for an adverse effect is evaluated by comparing the exposure level (intake) over a time period with an RfD derived for a similar exposure period that is unlikely to result in an adverse health effect. The estimated intake of each chemical through an individual route of exposure is divided by its RfD. When the resulting quotient or hazard quotient, exceed unity (i.e., intake exceeds RfD), there is potential for an adverse health effect (EPA 1989a). The potential for an adverse effect increases the more the hazard quotient exceeds unity.

To assess the potential for noncarcinogenic effects posed by multiple chemicals and exposure pathways, a "hazard index" approach has been adopted (EPA 1989b). The method assumes dose additivity. Hazard quotients are summed to provide a hazard index. When the hazard index exceeds one, there is a potential for a cumulative adverse health effect. The hazard index can exceed one even if no single chemical intake exceeds its RfD.

4.2 CARCINOGENIC RISKS

The potential for carcinogenic effects is evaluated by estimating excess lifetime cancer risk, which is the probability of developing cancer during one's lifetime over the background probability of developing cancer (i.e., if no exposure to site contaminants occurred). For example, a 1×10^{-6} (E-06) excess lifetime cancer risk means that for every 1 million people exposed to the carcinogen throughout their lifetime (which is typically assumed to be 70 years) at the defined exposure conditions, the average incidence of cancer is increased by one extra case of cancer. Because of the methods used to estimate CSFs, the excess lifetime cancer risks estimated in this preliminary risk assessment should be regarded as upper bound potential cancer risks rather than an accurate representation of the true cancer risk. The actual risk is expected to be considerably less and could approach zero.

The acceptable exposure level for carcinogens relative to Superfund site remediation goals as specified in the NCP is defined as the concentration corresponding to an excess upper-bound lifetime cancer risk to an individual of 10^{-4}, or E-04 (one-in-ten-thousand), to 10^{-6}, or E-06 (one-in-one-million) depending on the site, proposed usage, and chemicals of concern (EPA 1989a). Within this range, the level of risk which is considered to be acceptable at a specific site is a risk management decision and is decided on a case-specific basis. It is generally accepted that sites resulting in risks exceeding this range require attention. The one-in-a-million risk level, or E-06, is often referred to as the *de minimis* level of risk; sites resulting in calculated risks less than this would not require attention. The CSFs are generally upper 95th percentile values (upper-bound estimates) based on experimental animal data to predict the probability of humans developing cancer over a 70-year lifetime. Therefore, the derived estimate provides reasonable insurance that the "true risk" will not be exceeded and is likely to be less.

Furthermore, the one-in-a-million risk level is a theoretical prediction that no more than one person out of a million lifetimes would contract cancer due to an environmental exposure. By the way of comparison, the average person in the U.S. incurs a background risk of cancer (from all causes) of about one chance in four (0.25). Adding a risk of 0.000001 (E-06) to a background risk of 0.25 is of little significance to any single individual. These small risk levels may be of concern only if the exposed population includes many millions of people.

4.3 ESTIMATED RISKS-QUANTITATIVE ASSESSMENT

Noncarcinogenic hazards and carcinogenic risks have been calculated for each exposure pathway and for each COPC. Risks for individual chemicals are summed to estimate multi-chemical risks for each exposure pathway. A summary of estimated risks for chronic residential exposure to groundwater (average and RME scenarios) from the Muscoy Plume OU area for both noncarcinogenic effects and carcinogenic risk are discussed in the following paragraphs.

The exposure scenario for the Muscoy Plume OU area assumes a future resident would come in contact with groundwater at the site through domestic use of tap water. Noncarcinogenic exposure levels do not exceed the RfDs for any individual COPC or for the sum of all eight COPCs. For the RME scenario, the sum of the hazard quotients, as presented in Table 5, are 0.14 for the ingestion (oral) route and 0.49 for the inhalation route. The overall noncancer hazard index (i.e., multi-chemical, multi-exposure pathways) from RME to groundwater in the Muscoy Plume OU area is 0.63. The major chemical contributor to the overall noncancer hazard index, based on reasonable maximum ingestion and inhalation exposures, is PCE (0.35). For average ingestion and inhalation exposure from the use of tap water, as shown in Table 6, the sum of the noncancer hazard quotients are 0.09 for the ingestion (oral) route and 0.34 for the inhalation route. The total hazard index, based on an average exposure scenario, is 0.43.

The estimated excess lifetime cancer risk for the RME scenario, as shown in Table 7, is 2.08E-05 for the oral route (ingestion), and 2.90E-05 for the inhalation route. The total estimated lifetime cancer risk for RME through domestic use of groundwater is 4.98E-05. The major chemical contributor to the estimated lifetime cancer risk for the RME scenario is PCE (4.14E-05). Estimated excess lifetime cancer risks for average ingestion and inhalation exposures to tap water, as shown in Table 8, are 4.21E-06 and 5.96E-06, respectively. The total estimated lifetime cancer risk for average residential exposure through domestic use of groundwater is 1.0E-05.

Table 5

SYSTEMIC TOXICITY SUMMARY
CHRONIC HAZARD INDEX ESTIMATES
REASONABLE MAXIMUM EXPOSURE

Chemical	Concentration (C_w) (mg/ℓ)	Ingestion			Inhalation			Hazard Index
		Intake (mg/kg-day)	RfD (mg/kg-day)	Hazard Quotient	Intake (mg/kg-day)	RfD (mg/kg-day)	Hazard Quotient	
Tetrachloroethene (PCE)	0.027	7.72E-04	0.01	0.077	2.7E-03	0.01	0.27	0.35
Trichloroethene (TCE)	0.006	1.72E-04	0.006	0.027	6.0E-04	0.006	0.10	0.13
cis-1,2-Dichloroethene	0.006	1.72E-04	0.01	0.017	6.0E-04	0.01	0.06	0.08
trans-1,2-Dichloroethene	0.0004	1.14E-05	0.02	0.0001	4.0E-05	0.02	0.002	0.002
1,1-Dichloroethane	0.0008	2.29E-05	0.10	0.0002	8.0E-05	0.14	0.0006	0.001
1,2-Dichloropropane	0.0003	8.58E-06	0.0011	0.008	3.0E-05	0.0011	0.027	0.04
Dichlorodifluoromethane (Freon 12)	0.017	4.72E-04	0.20	0.002	1.7E-03	0.057	0.030	0.03
Trichlorofluoromethane (Freon 11)	0.004	1.14E-04	0.30	0.0004	4.0E-04	0.20	0.002	0.002
Vinyl Chloride	0.0001(1)	2.86E-06	NA	NA	1.0E-05	NA	NA	NA
TOTAL				0.14			0.49	0.63

Hazard Quotient = Intake / Reference Dose (RfD)

Intake (mg/kg-day) = $\frac{C_w \times IR \times EF \times ED}{BW \times AT}$ = C_w x 0.0286 ℓ/kg-day (for ingestion); C_w x 0.1 ℓ/kg-day (for inhalation)

See Table 2 for exposure variable values.
(1) Concentration estimated, data qualitatively acceptable (J-qualified).
NA = Not available.

Table 6

SYSTEMIC TOXICITY SUMMARY
CHRONIC HAZARD INDEX ESTIMATES
AVERAGE EXPOSURE

Chemical	Concentration (C_w) (mg/ℓ)	Ingestion			Inhalation			Hazard Index
		Intake (mg/kg-day)	RfD (mg/kg-day)	Hazard Quotient	Intake (mg/kg-day)	RfD (mg/kg-day)	Hazard Quotient	
Tetrachloroethene (PCE)	0.027	5.18E-04	0.01	0.0518	1.85E-03	0.01	0.185	0.237
Trichloroethene (TCE)	0.006	1.15E-04	0.006	0.0192	4.11E-04	0.006	0.0685	0.088
cis-1,2-Dichloroethene	0.006	1.15E-04	0.01	0.0115	4.11E-04	0.01	0.0411	0.053
trans-1,2-Dichloroethene	0.0004	7.68E-06	0.02	0.0004	2.74E-05	0.02	0.0014	0.002
1,1-Dichloroethane	0.0008	1.54E-05	0.10	0.0002	5.48E-05	0.14	0.0004	0.0006
1,2-Dichloropropane	0.0003	5.76E-06	0.0011	0.0052	2.06E-05	0.0011	0.0187	0.024
Dichlorodifluoromethane (Freon 12)	0.017	3.26E-04	0.20	0.0016	1.16E-03	0.057	0.0204	0.022
Trichlorofluoromethane (Freon 11)	0.004	7.68E-05	0.3	0.0003	2.74E-04	0.20	0.0014	0.002
Vinyl Chloride	0.0001(1)	1.92E-06	NA	NA	6.85E-06	NA	NA	NA
TOTAL				0.09			0.34	0.43

Hazard Quotient = Intake / Reference Dose (RfD)

Intake (mg/kg-day) = $\frac{C_w \times IR \times EF \times ED}{BW \times AT}$ = C_w x 0.0192 ℓ/kg-day (for ingestion); C_w x 0.0685 ℓ/kg-day (for inhalation)

See Table 2 for exposure variable values.

(1) Concentration estimated, data qualitatively acceptable (J-qualified).

NA = Not available.

Table 7

CARCINOGENIC RISK ESTIMATES
REASONABLE MAXIMUM EXPOSURE

Chemical	Concentration (C_w) (mg/ℓ)	Ingestion			Inhalation			Estimated Chemical-Specific Cancer Risk
		Intake (mg/kg-day)	CSF (mg/kg-day)	Estimated Cancer Risk	Intake (mg/kg-day)	CSF (mg/kg-day)	Estimated Cancer Risk	
Tetrachloroethene (PCE)	0.027	3.29E-04	0.052	1.71E-05	1.16E-03	0.021	2.43E-05	4.14E-05
Trichloroethene (TCE)	0.006	7.32E-05	0.015	1.10E-06	2.57E-04	0.010	2.57E-06	3.67E-06
cis-1,2-Dichloroethene	0.006	7.32E-05	NA	NA	2.57E-04	NA	NA	NA
trans-1,2-Dichloroethene	0.0004	4.88E-06	NA	NA	1.72E-05	NA	NA	NA
1,1-Dichloroethane	0.0008	9.76E-06	NA	NA	3.43E-05	NA	NA	NA
1,2-Dichloropropane	0.0003	3.66E-06	0.068	2.49E-07	1.29E-05	0.068	8.75E-07	1.12E-06
Dichlorodifluoromethane (Freon 12)	0.017	2.07E-04	NA	NA	7.29E-04	NA	NA	NA
Trichlorofluoromethane (Freon 11)	0.004	4.88E-05	NA	NA	1.72E-04	NA	NA	NA
Vinyl Chloride	0.0001(1)	1.22E-06	1.9	2.32E-06	4.29E-06	0.30	1.29E-06	3.61E-06
TOTAL				2.08E-05			2.90E-05	4.98E-05

Carcinogenic Risk = Intake x CSF

Intake (mg/kg-day) = $\frac{C_w \times IR \times EF \times ED}{BW \times AT} = C_w \times 0.0122$ ℓ/kg-day (for ingestion); $C_w \times 0.0429$ ℓ/kg-day (for inhalation)

See Table 2 for exposure variable values.

(1) Concentration estimated, data qualitatively acceptable (J-qualified).

NA = Not Applicable or not classified as a human carcinogen (i.e., EPA Group D or E); see Table 4.

Table 8

CARCINOGENIC RISK ESTIMATES AVERAGE EXPOSURE

Chemical	Concentration (C_w) (mg/ℓ)	Ingestion			Inhalation			Estimated Chemical-Specific Cancer Risk
		Intake (mg/kg-day)	CSF (mg/kg-day)	Estimated Cancer Risk	Intake (mg/kg-day)	CSF (mg/kg-day)	Estimated Cancer Risk	
Tetrachloroethene (PCE)	0.027	6.67E-05	0.052	3.47E-06	2.38E-04	0.021	4.99E-06	8.46E-06
Trichloroethene (TCE)	0.006	1.48E-05	0.015	2.22E-07	5.28E-05	0.010	5.28E-07	7.50E-07
cis-1,2-Dichloroethene	0.006	1.48E-05	NA	NA	5.28E-05	NA	NA	NA
trans-1,2-Dichloroethene	0.0004	9.88E-07	NA	NA	3.52E-06	NA	NA	NA
1,1-Dichloroethane	0.0008	1.98E-07	NA	NA	7.04E-06	NA	NA	NA
1,2-Dichloropropane	0.0003	7.41E-07	0.068	5.04E-08	2.64E-06	0.068	1.80E-07	2.30E-07
Dichlorodifluoromethane (Freon 12)	0.017	4.20E-05	NA	NA	1.50E-04	NA	NA	NA
Trichlorofluoro/methane (Freon 11)	0.004	9.88E-06	NA	NA	3.52E-05	NA	NA	NA
Vinyl Chloride	0.0001[1]	2.47E-07	1.9	4.69E-07	8.80E-07	0.30	2.64E-07	7.33E-07
TOTAL				4.21E-06			5.96E-06	1.02E-05

Carcinogenic Risk = Intake x CSF

Intake (mg/kg-day) = $\frac{C_w \times IR \times EF \times ED}{BW \times AT}$ = C_w x 0.00247 ℓ/kg-day (for ingestion); C_w x 0.0088 ℓ/kg-day (for inhalation)

See Table 2 for exposure variable values.

(1) Concentration estimated, data qualitatively acceptable (J-qualified).

NA = Not Applicable or not classified as a human carcinogen (i.e., EPA Group D or E); see Table 4.

Chemical-specific standards that define acceptable human health risk levels, such as MCLs, are also used in determining whether an exposure presents an unacceptable risk and whether remedial action is warranted (EPA 1991b). The MCLs are the maximum permissible concentration of a chemical in water, which is delivered to any user of a public water system (see Table 1 for both state and federal MCLs for the COPCs). In the Muscoy Plume OU, PCE levels in the municipal wells generally exceed the MCL, while the TCE concentration in these same wells only occasionally exceed the MCL. If PCE and TCE were treated to MCLs of 5 $\mu g/\ell$, respectively, and all other conditions and assumptions remained at the RME scenario described above, the total estimated lifetime cancer risk for reasonable maximum residential exposure through domestic use of groundwater would be 1.5E-05.

5.0 UNCERTAINTIES

The risk assessment is subject to uncertainty from a variety of sources. The main contributors to uncertainty include: sampling and analysis, fate and transport estimation, exposure estimation, and toxicological data.

Although risk assessment follows a formal scientific approach, making assumptions based on professional judgment is an inherent part of the process. Uncertainties inherent in the estimation of exposure and risks may act either to increase or decrease the identified risks, depending on the source of the uncertainty. This assessment is based upon the present understanding of the site characteristics, exposure and toxicity.

5.1 UNCERTAINTY IN EXPOSURE ASSESSMENT

Evaluation of uncertainty is an important component of the exposure assessment. Exposure point concentrations may be overestimated or underestimated depending on the conditions assumed and the actual conditions of exposure at the site.

Uncertainty in the quantitative estimates of chemical intakes is associated with each of the following assumptions under each scenario:

1. The 95 percent UCL of the arithmetic mean, or maximum detected value, whichever was lower, was used to estimate exposure point concentrations and to represent the amount of chemical present in the groundwater. Using the maximum detected value in lieu of the 95 percent UCL is a conservative approach necessitated by the limited number of data points. Actual chemical concentrations present in the groundwater are likely to be considerably lower. Nevertheless, historic groundwater contaminant concentrations have shown temporal and spatial variability.

2. Exposure scenarios represent idealized, albeit conservative, estimates of situations that may or may not represent actual, current, or future conditions.

3. The toxicity of potential COPC transformation products, whether having greater or less severe toxicity effects than chemicals discussed herein, are not accounted for in this evaluation.

4. The contamination in groundwater may not possess the mass or quantity of chemicals to provide the duration of exposure at the concentrations used in each exposure scenario. The actual level and duration of exposure could be highly variable and the actual exposure overestimated.

5. The estimated intake from inhalation of VOCs from all household uses of the groundwater (showering, bathing, and other domestic uses) is based on an upper-bound volatilization constant which may be an overestimation (see Andelman 1990; EPA 1991d). However, since PCE and TCE are known to be readily absorbed across the surface of the lungs and background levels of these VOCs (which were not considered in this assessment) are commonly detected in both the indoor and ambient air environments throughout the state, inhalation constitutes a potentially significant route of exposure (CARB 1990, 1991).

6. Exclusion of the dermal route of exposure from this risk assessment, based on the assumption that it is not significant, could underestimate the total risk.

7. Several of the COPCs (1,2-dichloropropane, trans-1,2-dichloroethene) were detected infrequently in samples from most wells in the Muscoy Plume OU, and some data were J-qualified. The convention (i.e., assuming a concentration equal to one-half of the detection limit) used to estimate the concentration of analytes that were not detected above the detection or quantitation limit likely overestimated the concentrations of some COPCs.

Therefore, the scenarios used herein possibly overestimate actual exposure conditions existing within the OU. Nevertheless, the exposure assessment attempted to provide best estimates within a margin of safety rather than extreme estimates with respect to both the magnitude and duration of exposure.

5.2 UNCERTAINTY IN TOXICITY INFORMATION

Varying degrees of uncertainty are associated with the toxicity values used to estimate potential health risks. Sources of uncertainty are due to the following:

1. The actual dose-response parameters and mathematical models used numerically estimated values based on animal studies (i.e., toxic effects of chemicals on laboratory animals).

2. Uncertainty is introduced by using the results of dose-response animal toxicity studies to predict adverse health effects that may occur following human exposure to the low contaminant levels in the groundwater. This uncertainty associated with animal toxicity studies includes predicting the human health effects from short-term and long-term exposures. The margins of safety inherent in the toxicity values derived for each chemical are meant to be over-protective. Margins of safety for noncarcinogenic (threshold) chemicals are incorporated through the use of uncertainty factors when extrapolating the results of animal toxicity studies to predict the effect in humans. Margins of safety for carcinogenic (non-threshold) chemicals are incorporated by using the 95 percent UCL of the toxicity value. This value represents an upper 95 percent

confidence limit on the probability of a response per unit intake of a chemical over a lifetime (i.e., there is only a 5 percent chance that the probability of a response could be greater than the estimated value on the basis of the experimental data and model used to generate the toxicity value [EPA 1989a]).

3. Toxicity values derived from the IRIS database system were accompanied with a qualitative description of their "weight-of-evidence" as determined by the Carcinogen Risk Assessment Verification Endeavor (CRAVE) Workgroup; the corresponding confidence in each toxicity value was added to the uncertainty.

4. The current state (Cal EPA) cancer potency slope factors are considered in the derivation of toxicity values. The more stringent, and more protective, CSFs for TCE (oral and inhalation CSFs) and PCE (inhalation CSF) are used rather than the EPA (ECAO) values. Because the state CSFs lack the extensive CRAVE Workgroup peer review and do not represent an EPA consensus there is greater uncertainty associated with these values.

5. The use of oral RfDs for inhalation RfDs increases the uncertainty of the values due to potential differences in absorption rates.

5.3 UNCERTAINTY IN THE CHARACTERIZATION OF RISKS

The characterizations of risks are not fully probabilistic estimates of the risk because no quantitative measures of uncertainty are associated with each numerical estimate. Rather, the risks are conditional estimates based on a considerable number of professional and subjective assumptions about exposure and toxicity. The uncertainty about the numerical result is large (i.e., in the range of at least an order of magnitude or greater). It is more important to identify the key site-related variables and assumptions that contribute most to the uncertainty than to precisely quantify the degree of uncertainty in the risk characterization. The basic methodology used in this risk assessment was developed by EPA specifically for evaluation of risk at hazardous waste sites (EPA 1989a). Overall, this methodology is conservative, which means that the true risks from the site are unlikely to be higher than the derived estimates, and are most likely lower.

6.0 ECOLOGICAL ASSESSMENT

This section addresses the potential ecological risks to flora and fauna in the Muscoy Plume OU and surrounding area. It provides a qualitative evaluation of potential current and future ecological risks represented by exposure to existing groundwater contaminants.

6.1 POTENTIAL ECOLOGICAL RECEPTORS

6.1.1 Site Description

The Muscoy Plume OU is zoned for residential, commercial and industrial land use. Except for the alluvial fans and floodplains, the Muscoy Plume OU and surrounding area is primarily a mixture of residential and commercial zoning. Urban activities have modified much of the San Bernardino Valley (Valley). Urban land uses and past agricultural operations have removed much of the native vegetation from the alluvial fans and floodplains of the Valley floor. Dominant remaining vegetation types consist of chaparral, sage scrub, and occasional riparian areas. Apart from isolated remnants, the vegetation in the Muscoy Plume OU and surrounding areas consists primarily of introduced landscape species. Consequently, the area supports a limited diversity of plant and animal life. Sensitive habitats are primarily associated with coastal sage scrub and remnant riparian communities in the floodplains of the reaches of the Santa Ana River and its tributaries within and downstream of the Muscoy Plume OU.

6.1.2 Ecological Setting

Vegetation in and along the upper Santa Ana River basin and Valley tributaries is a reflection of the local occurrence of permanent water, surface or groundwater. The presence of permanent water near the surface in stream channels provides a favorable condition for the establishment of vegetation.

In some areas of the Muscoy Plume OU, the alluvial fans and floodplains support a distinctive scrub vegetation, Riversidean alluvial fan sage scrub, a variation of Riversidean sage scrub. Riversidean alluvial fan sage scrub, a sensitive plant community (i.e., plant community with highest inventory priority), is the dominant habitat of the upper Santa Ana River floodplain and Cajon and Lytle wash areas that are still subject to natural flooding. The plant community grows on undisturbed, severely drained soils or clays of floodplain areas and is typically dominated by a diverse assemblage of low, half-woody aromatic drought deciduous shrubs. The vegetation experiences periodic natural flood events which remove vegetation and rework soils, resulting in a new cycle of plant succession. Areas that are protected from flooding follow a successional pattern resulting in plant communities resembling upland chaparral. The habitat quality for native plants in these areas, including two endangered species, is further reduced by the presence of various herbaceous weedy plants.

The California Natural Diversity Data Base or "RareFind" (NDDB 1993) reports the occurrence of Riversidean alluvial fan sage scrub in washes on either side of Glen Helen Rehabilitation facility near Lytle Creek and Cajon Canyon. Two federal and state listed endangered plant species are associated with this habitat: the Santa Ana River woollystar (*Eriastrum densifolium* ssp. *sanctorum*) and the slender-horned spineflower (*Centrostegia leptoceras*).

The Santa Ana River woollystar is a perennial summer-blooming (June - August) shrub that reaches a height of approximately 75 centimeters. The flowers have blue corollas, up to 32 millimeters in length, contained in heads with about 20 blossoms (Munz 1973). Three other subspecies are recognized; the range of one of these, *E. d.* ssp *elongatum*, the more common unlisted subspecies which is similar in height but with shorter corolla lengths (15 - 16 mm.), may overlap with *E. d.* ssp *sanctorum* (USFWS 1988). The species is primarily restricted to a few populations on Lytle Creek and the Santa Ana River floodplain between Redlands and Santa Ana Canyon, near Mentone. Most of the habitat has been eliminated by urbanization, flood control activity, agriculture, and aggregate mining. The NDDB reported three occurrences of the species in the Muscoy Plume OU area consisting of locations (1) along the west side of Lytle Creek Wash near Glen Helen Rehabilitation Facility, (2) west branch of Lytle Creek Wash east of Frisbie Park and south of Highland Avenue, and (3) west of Lytle Creek Wash on the south side of Baseline Avenue. It should be noted that surveys conducted by Tierra Madre Consultants (1991) in the Cajon Wash area found only the more common subspecies of woollystar, *E. d. elongatum*, not the endangered woollystar.

The slender-horned spineflower (*Centrostegia leptoceras*) is a small, prostrate or decumbent, forked, spring-flowering (April - June) annual of the buckwheat family (Munz 1973). Historically, the species was found on dry sandy alluvial benches within coastal sage scrub vegetation. Much of the population has been lost to urbanization, flood control, and off-road vehicles (CNPS 1988). The absence of periodic flooding, upon which the plant is dependent, together with the loss and/or alteration of habitat, has resulted in the plant's listing as both a federal and state endangered species. Although there were no reported occurrences in the NDDB data base within the Muscoy Plume OU or during surveys conducted by Tierra Madre Consultants (1990), Tierra Madre reported the presence of suitable habitat in an area of Cajon Wash extending south of Institution Road.

The Riversidean alluvial fan sage scrub community plant assemblage (including California buckwheat, California sagebrush, brittle bush, coastal prickly pear), provides cover and abundant seeds and plant material for herbivorous animals, as well as foraging habitat for birds of prey in the Muscoy Plume OU and adjacent areas. Fauna utilizing or ranging over this habitat in the Muscoy Plume OU and adjacent areas include:

- Reptiles. San Diego horned lizard and orange-throated whiptail, both of which are federal Category 2 candidates for listing and California Department of Fish and Game (DFG) species of special concern. Other common reptiles include gopher snake, side-blotched lizard, zebra-tailed lizard, and red racer.

- Birds. California gnatcatcher, listed in 1993 by USFWS as a threatened species. Sensitive raptors (California species of special concern) such as northern harrier, golden eagle, sharp-shinned hawk, prairie falcon. Other common birds include brown towhee, California thrasher, California quail, Berwick's wren, loggerhead shrike, and house sparrow.

- Mammals. Deer mouse, desert cottontail, California ground squirrel, Beechy ground squirrels, Botta pocket gopher, kangaroo rats, wood rats, coyote, gray fox, bob cat. Possibly the Los Angeles pocket mouse, a California species of special concern and federal Category 2 candidate for listing, which was identified by Tierra Madre Consultants (1990) as occurring on San Bernardino County Flood Control property in an area near Cajon Wash north of Institution Road.

6.2 CHARACTERIZATION OF ECOLOGICAL EXPOSURE AND EFFECTS

The ecological stressor of primary concern at this site is the potential discharge of contaminated groundwater to surface water (i.e., chemical stressors). There is no information, at present, to indicate that there is a hydrogeologic groundwater-to-surface water connection, nor is there any known discharge, point or non-point, of untreated groundwater to a surface water source (canal, river, channel, storm sewer, etc.). Consequently, there is no complete exposure pathway to the ecological receptors of the Muscoy Plume OU which are principally located in and along the alluvial fans and floodplains of Lytle Creek and Lytle Creek Wash.

6.3 RISK CHARACTERIZATION

Except for the undisturbed alluvial plains and floodplains within Lytle Creek Wash and Lytle Creek which will not be affected, little habitat potential currently exists within the Muscoy Plume OU. Of the potential ecological receptors, particularly the sensitive habitats and listed plant species, there appears to be no apparent exposure pathway to the chemical stressors (COPCs) associated with the contaminated groundwater.

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